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Fire Costs, Losses, and Benefits:
An Economic Valuation Procedure

Robert J. Marty

Richard J. Barney

AUTHORS

ROBERT J. MARTY, originally from Illinois, has received degrees from Michigan State University, Duke University, Harvard University, and Yale University, in forestry, public administration, and economics. He worked for 12 years with the Forest Service and served as Branch Chief for Economics Research in Washington before going to Michigan State University in 1967. He is coauthor of a book on research planning called *Research Designs for Resource Decisions,* and has under development a text on forest administration called *Administering Public Lands and Resources.* He is also the author of many bulletins and articles, both State and Federal, with regard to the economic evaluation of forestry activities. He is a member of the American Economics Association, the Society for Public Administration, the American Association for the Advancement of Science, and the Michigan Academy of Science, Arts and Letters. His major professional interests are the economics and administration of natural resources.

RICHARD J. BARNEY received his bachelor's degree in 1958 and his master's degree in 1961 from the University of Montana, and his Ph.D. from Michigan State University in 1976, all in forestry. From 1958 to 1961 he worked on the Flathead National Forest. During the period 1961 to 1965 he was located at the Northern Forest Fire Laboratory involved in fire behavior and fire danger rating research. In 1965 he transferred to Fairbanks, Alaska, where he was Project Leader of the Alaska Fire Control Systems research unit. Following this assignment he returned to the Northern Forest Fire Laboratory where he is currently a team leader in the Fire Control Technology Project.

RESEARCH SUMMARY

A guidebook has been developed to assist the fire managers and planners in estimating actual economic costs, losses, and benefits resulting from fire management activities. This guidebook was developed and tested on 12 National Forests during the 1977-79 period. The procedures were developed primarily for Forest Service use but are adaptable to other agency and individual situations. Individual fire reports provide the basic fire inputs for the process while the guidelines lead the user on a stepwise basis through an array of economic processes. The procedure is based on 10 value components. Detailed instructions have been developed and a suggested working form provided. The authors point out that continued development and improvement of this type of process is an absolute necessity if sound management decisions are to result.

PREFACE

This guidebook was prepared as a part of the Fire in Multiple-Use Management Research, Development, and Application Program carried out by the Northern Forest Fire Laboratory in Missoula, Mont. The procedures contained in this guidebook were developed and tested on 12 National Forests during the 1977-79 period.[1] It is hoped that these proposed procedures will prove both practical and helpful to fire managers.

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INTRODUCTION

This guidebook is meant to aid fire managers and fire management planners on the National Forests develop improved estimates of the actual economic costs, losses, and benefits associated with fire management. Although these procedures were developed initially for Forest Service use, they are adaptable to other management situations. Improved valuation of fire management costs, losses, and benefits is a necessary precondition to more effective fire management planning.

"The basic fire management policy on National Forest System Lands is to provide well-planned and executed fire protection and fire use programs that are cost effective and responsive to land and resource management goals and objectives and supportive"[2] of the Resources Planning Act (RPA) outputs. In order to insure that fire management programs are cost effective and responsive, it is necessary to be able to compare program cost and benefits. Changes in fire protection programs cause changes in the number, size, or severity of wildfires. Is the change in program cost consistent with the change in net losses due to wildfire? Changes in fire use programs also are to be cost effective and responsive. Does a prescription fire create enough net benefits to justify its cost?

In order to answer such questions as accurately as possible it is necessary to have good estimates of the costs, losses, and benefits associated with both wildfires and prescription fires. Fire costs, losses, and benefits vary a great deal, depending on fire location, size, intensity, fuel condition, weather condition, type of vegetative cover, and many other factors.

The individual fire report now provides for estimates of the value of resources damaged or destroyed and for acres burned by value class. A more complete estimate of fire costs, losses, and benefits is needed. Resource damage is only a part of the picture. Also to be considered are life and health losses, rehabilitation costs, beneficial impacts of fire, and other value components. The value class concept is a useful one, but it does not provide an accurate estimate of damage or loss. For example, all fires in range grassland are assigned an average loss and damage of $250 per acre. In actual fact, some range fires produce a net loss, while others provide a net benefit.

The fire valuation procedures presented in this guidebook provide a more accurate and complete estimate of fire costs, losses, and benefits. They call for postfire examination of each class C and larger wildfire and each prescription fire, leading to a summarization of costs, losses, and benefits for each. After these data have been collected for several years it will be possible to accurately estimate for each fire management area the costs, losses, and benefits which have actually been experienced for fires of different sizes occurring in various vegetative types. The new valuation data collected each year will provide an automatic updating of value estimates, as well. With these improved valuation data it will be possible to carry out more accurate comparisons of the cost and benefit associated with changes in fire management programs.

[2]USDA Forest Service. 1978. Forest Service Manual. Title 5100 - Fire Management, 5103 Policy. Washington, D.C.

CONCEPTUAL BASIS

Valuation is the process of associating an economic value with the physical costs, losses, and resource changes that result from fire management programs. Valuation is accomplished by tracing the chain of events which occurs as the result of fire, to determine who has experienced a change in income or wealth and how large those changes are.

The Fire Valuation Model

Fire management gives rise to a chain of events which has certain economic results. Presuppression decisions and actions and actual wildfire experience and control effort lead to specific postcontrol conditions on fire sites. These physical effects, on and beyond fire sites, lead to productivity changes for the resources involved, which in turn may result in changes in resource use.

Precontrol decisions and actions determine the amount of presuppression fire management expenditure. Control itself occasions control expenditures for the Forest Service and for unreimbursed cooperators who contribute to the control effort. Fires result in other immediate losses as well, chief among which are property destruction or damage and life and health losses.

After control some wildfires give rise to the need for rehabilitation treatments and may cause changes in the productivity and thus the use of timber, forage, recreation, and other resources. Changes in use cause changes in the economic and social values that will be derived from fire management areas.

The fire valuation model has 10 value components. Each is briefly described below, and its valuation basis is identified. Detailed procedures for estimating each component are presented in the following section. These procedures call for an "Individual Fire Valuation Report" to be prepared for class C and larger wildfires and for all prescription fires. This fire valuation report records the physical effects of the fire, along with certain economic information which forms the basis for estimating economic impacts.

1. **Presuppression cost**.--Included here are presuppression costs both for the Forest Service and cooperating fire control agencies unreimbursed by the Forest Service. Forest level costs are prorated to fire management areas. An equal share of fire management area presuppression cost is assigned to each fire. The valuation basis is actual expenditures and obligations. Fire management expenditures at regional and Chief's Office levels are excluded.

2. **Suppression cost**.--Actual suppression costs for fires originating within the fire management area are included in this component. Suppression costs incurred for fighting fires originating outside the fire management area are excluded. Suppression efforts contributed by other Forest Service units or cooperators are included. The suppression efforts contributed by unreimbursed cooperators are valued at Forest rates, when actual expenditures cannot be determined. The valuation basis is actual expenditures and obligations, and suppression cost is assigned to individual fires on the basis of average suppression cost for its wildfire size class.

3. **Life and health loss**.--This component includes the cost of medical treatment for those injured or made ill as the direct result of a fire and the value of work time lost for all persons killed or injured. The valuation basis for medical treatment costs is average hospitalization costs outside standard metropolitan statistical areas, as reported by the American Hospital Association. The valuation basis for work time lost is based on the average net contribution to GNP[3] of employed persons.

4. **Property loss**.--Property loss includes damage or destruction of transportation equipment and facilities, communications facilities, land improvements, production structures and equipment, residences, recreation facilities and structures, agricultural crops, and livestock. The valuation basis for damaged but repairable property is the cost of the repair. For property damaged beyond repair, the valuation basis is depreciated value, based on original cost, age, and useful life. Replacement costs, an often suggested basis, is an overestimate of the value of partially depreciated property.

5. **Rehabilitation cost**.--Rehabilitation treatments on fire sites and beyond when necessitated by a fire are included in this component. Costs are estimated on the basis of recent cost experience. Rehabilitation treatments undertaken by others as the result of a fire are included. The valuation basis is estimated cost as a function of acreage to be treated and current average cost per acre for similar treatments on the forest. Although these treatments may not be undertaken for several years, no attempt is made to discount in this component because the timelag usually is short.

6. **Timber effects**.--Included in this component is the value of cut timber products destroyed, together with the value of stumpage under sale contract destroyed less the value of timber salvaged from the fire site. The valuation basis for these elements is current value to the buyer for products destroyed or salvaged. In addition, this component includes an estimate of the present value of future changes in timber output caused by fire. This estimate is based on the volume of merchantable stumpage destroyed, the growth loss or gain in immature stands, current average stumpage prices, and the assumption that losses or gains will be reflected in an equal annual change in timber sales over a 100-year rotation. This estimate assumes that any timber lost or gained because of fire would eventually have found a market.

7. **Forage effects**.--This component comprises the value of forage destroyed and of the change in future forage output. The value of forage destroyed in active allotments is based on volume and current value to the buyer per AUM. The discounted value of future changes in forage output are based on current price per AUM.

8. **Recreation effects**.--Fire may influence developed site recreation, disbursed recreation, and wilderness recreation. It is assumed here that fire curtails recreational

[3]Abbreviations and acronyms are defined in appendix I.

use of a burned area for an average of 6 months, whereupon recreational use will be resumed on the burned area or will have been relocated elsewhere. The valuation bases of this component are the 1980 RPA assessment values for recreational use.

9. **Wildlife effects.**--Fire may either increase or decrease the amount of hunting and fishing on burned areas and, in some cases, downstream from them. Estimates of the changes caused by fire to five different categories of hunting and fishing are valued by using 1980 RPA assessment values.

10. **Water effects.**--Until a burned area again supports adequate vegetative cover, fires can cause increases in water yield from burned areas as well as reductions in water quality caused by increased sedimentation and other factors. Changes in water yield and water quality are valued by using 1980 RPA assessment values.

Important Attributes of the Model

Here are some important points about the fire valuation model that users should understand:

1. The model is constructed in such a way that it will provide estimates of the economic impacts of both wildfire and prescription fire. Both kinds of fire can cause costs, losses, and benefits. In wildfires, costs and losses often outweigh benefits. For prescription fires benefits should exceed costs and losses.

2. The model includes the costs and losses of and benefits to not only the Forest Service, but to fire management cooperators, and to loggers, ranchers, and recreationists as well. The means of accomplishing this are to include the cost of fire management paid for by other organizations and individuals and to value changes in timber, forage, recreation use, wildlife, and water on the basis of their value to the user, rather than from the standpoint of the receipts they generate to the Federal government. The unit values of outputs are based on current forest experience or are derived from value estimates used in the 1980 RPA assessment.

3. Although much of the economic impact of fire is concentrated in the year of occurrence, other costs, losses, and benefits crop up during subsequent years and decades. Economic impacts occurring in future years are discounted to the present, using a 5 percent or 10 percent discount factor. The 5 percent rate is recommended because it approximates the 1969-78 average interest paid on long-term Federal government debt. The 10 percent discount factor is the one currently (1979) required by Office of Management and Budget (OMB).

THE INDIVIDUAL FIRE VALUATION REPORT

A basis must exist for estimating the physical effects of fires. Not all wildfires cause damage or output change, of course. Many class A and B fires have little or no effect, but many larger fires do cause such changes. Methods for estimating change in the physical productivity of resource systems lies outside the scope of this publication. This guidebook is concerned with valuing such changes once they have been identified. During the testing of the valuation procedures, however, it became apparent that currently available records were not satisfactory in all regards for establishing physical losses and changes in resource outputs. An attempt was made to use the Individual Fire Report, Form 5100-29, as a basis. It would be possible to modify fields 41-44 of this report, which record the value of resources damaged or destroyed and area by value classes, to provide a more adequate basis for valuation. But, because of the rapid reporting time required for Form 5100-29, it seems more appropriate to recommend an additional report, an Individual Fire Valuation Report. This new report would be completed only for class C and larger fires and as sufficient time becomes available for a careful examination of the fire site. The Individual Fire Valuation Report also should be used to record the effect of prescribed fires on resource system outputs.

The report form (fig. 1) in a preliminary format and detailed instructions for completing each item follow.

Preparing the Individual Fire Valuation Report

This report is to be prepared for all class C or larger wildfires and for all prescription fires.

IDENTIFICATION ITEMS

Item 1. **Forest**. Enter name of Forest initially responsible for action.

Item 2. **Fire Management Area**. Enter name of fire management area within which initial ignition occurred.

Item 3. **Fire Name**. If a wildfire, enter fire name from Form 5100-29. If a prescription fire, enter "Prescription Fire."

Item 4. **Fire Number**. If a wildfire, enter supervisor fire number from Item 5, Form 5100-29. If a prescription fire, enter P-01, -02, -03 . . . in order by date of occurrence.

Item 5. **Date of Fire**. From Form 5100-29 or prescription fire record.

Item 6. **Date of Report**. Enter date report is completed.

Item 7. **Prepared By**. Enter name of officer preparing the report.

CONTROL INFORMATION ITEMS

Item 8. **Area Burned**. Enter from Item 36, Form 5100-29 or prescription fire record.

Item 9. **Unreimbursed Suppression Effort**. Estimate the number of man-days of effort contributed by personnel not paid from Forest funding. Include here personnel from other Forest Service units, from State fire control agencies, and from timber harvesting companies, when no charge against Forest funding or direct reimbursement has or will be made. These unreimbursed man-days will be valued at the average cost per man-day of fire control on the Forest and included in the total cost of control.

INDIVIDUAL FIRE VALUATION REPORT

Page 1

IDENTIFICATION

1. Forest _____ 2. Fire Management Area _____
3. Fire Name _____ 4. Fire Number _____
5. Date of Fire _____ 6. Date of Report _____
7. Prepared by _____

CONTROL INFORMATION

8. Area Burned _____ 9. Unreimbursed Suppression Effort _____

DEATHS, INJURIES AND ILLNESSES

10. Name	11. Age at Death	12. Length of Hospitalization (days)

13. Worktime Lost

_____
_____
_____
_____
_____

INDIVIDUAL FIRE VALUATION REPORT

Page 2

PROPERTY LOSS

14. Kind of Property	15. Original Cost or Cost of Repair	16. Age

REHABILITATION TREATMENTS

17. Treatment Type	18. Treatment Area (acres)	19. Treatment Cost (dollars)

Figure 1.--*Proposed form for an Individual Fire Valuation Report.*

INDIVIDUAL FIRE VALUATION REPORT

Page 3

TIMBER EFFECTS

20. Value of cut timber products destroyed _____ (dollars)

Stumpage under sale contract destroyed.

21. M bd.ft._____ 22. Price per M bd.ft._____(dollars)

23. Cds. _____ 24. Price per cord _____(dollars)

Volume of stumpage salvaged:

25. M bd.ft._____ 26. Price per M bd.ft._____(dollars)

27. Cds. _____ 28. Price per cord _____(dollars)

Unsalvaged merchantable stumpage destroyed:

29. M bd.ft._____ 30. Cds. _____

Growing stock losses and gains

31. Growing stock losses: M bd.ft._____ Cds._____

____ Cds._____

er AUM _____ (dollars)

es) 36. Average annual per acre

_____ (AUM's)

_____ (years)

INDIVIDUAL FIRE VALUATION REPORT

Page 4

RECREATION EFFECTS

Current annual use of recreation facilities within the burned area:

38. RVD's _____

Current annual dispersed recreational use of burned area:

39. RVD's _____

Current annual wilderness recreational use of burned area:

40. RVD's _____

WILDLIFE EFFECTS

	41. Change in RVD's
Anadromous sport fishing	_____
Other sport fishing	_____
Small game and upland game bird hunting	_____
Waterfowl hunting	_____
Big game hunting	_____

WATER EFFECTS

Increase in water yield:

42. AF _____ 43. Duration of effect _____

Reduction in water quality:

44. AF _____ 45. Duration of effect _____

OTHER EFFECTS

46. Description of effects:

COST, LOSS, AND BENEFIT SUMMARY

		5% Present Values		10% Present Values	
		Cost or Loss	Benefit	Cost or Loss	Benefit
Item 47.	Presuppression cost				
Item 48.	Suppression cost				
Item 49.	Life and health loss				
Item 50.	Property loss				
Item 51.	Rehabilitation cost				
Item 52.	Timber effects				
Item 53.	Forage effects				
Item 54.	Recreation effects				
Item 55.	Wildlife effects				
Item 56.	Water effects				
	Totals	_____	_____	_____	_____
Item 57.	Net Present Values	_____		_____	

DEATHS, INJURY, AND ILLNESS ITEMS

Item 10. **Name**. List the name of each person who died, was injured, or became ill as the result of the fire, that is, where the death, injury, or illness would not have occurred if there had been no fire. If name is unknown enter "Unknown Person." Non-Forest Service personnel are to be included.

Item 11. **Age at Death**. For persons killed as the result of the fire, enter their age at death. If unknown, enter approximate age and enclose in parentheses.

Item 12. **Length of Hospitalization**. For all persons admitted to a medical facility for treatment, enter the number of days before death or release. Enter "1 day" for those hospitalized for less than 24 hours. If person was hospitalized, but length of stay is unknown, enter "unknown." For persons not hospitalized, enter "none."

Item 13. **Worktime Lost.** For all persons injured or made ill by the fire, enter the number of days or months of worktime lost. If unknown, enter "unknown."

PROPERTY LOSS ITEMS

Item 14. **Kind of Property**. For each item of property damaged or destroyed, enter a description. Include non-Forest Service property.

Item 15. **Original Cost or Cost of Repair**. For each item of property listed in item 14 which was damaged beyond repair, enter an estimate of original cost. For agricultural crops, original cost is the cost of establishing and tending incurred before the crop was destroyed. For property that is damaged but repairable, estimate cost of repair.

Item 16. **Age**. For each item of unrepairable property listed in item 14, enter the age of the equipment or structure. For orchards, vineyards, and other perennial agricultural crops, age is the number of years since establishment.

REHABILITATION TREATMENT ITEMS

Item 17. **Treatment Type**. For each rehabilitation treatment planned, enter the type of treatment, for example tree planting, grass seeding, etc.

Item 18. **Treatment Area**. For each treatment listed in Item 17, enter the area to be treated in acres.

Item 19. **Treatment Cost**. For each item listed in item 17, enter the expected cost of treatment per acre. Base this estimate on current costs for similar treatments on the National Forest.

TIMBER EFFECTS ITEMS

Item 20. **Value of Cut Timber Products Destroyed.** Enter the value of any logs, poles, posts, and other cut timber products destroyed. If value is unavailable from owner, it may be calculated by multiplying volume of products destroyed by the sum of stumpage price plus average logging cost per M bd.ft. or cord. Stumpage prices and logging cost estimates for the sale are available from timber sales records.

Item 21. **M bd.ft.** Enter here the volume of sawtimber or other board foot measure stumpage under sale contract which has been destroyed.

Item 22. **Price Per M bd.ft.** Enter the price per thousand board feet specified in the sale contract for destroyed stumpage listed in item 21.

Item 23. **Cds**. Enter here the volume of pulpwood and other cord measure stumpage under sale contract which has been destroyed.

Item 24. **Price Per Cord**. Enter the price per cord specified in the sales contract for destroyed stumpage listed in item 23.

Item 25. **M bd.ft.** Enter here volume of sawtimber and other board measure stumpage which has been or will be sold by salvage sale.

Item 26. **Price Per M bd. ft**. Enter the price per thousand board feet for salvage stumpage listed in item 25. Obtain this price from salvage sale records, or from timber staff preparing the salvage sale.

Item 27. **Cds**. Enter here the volume of pulpwood or other cord, measure stumpage which has been or will be sold by salvage sale.

Item 28. **Price Per Cord**. Enter the price per cord for salvage stumpage listed in item 27.

Item 29. **M bd.ft.** Enter here the volume of unsalvaged merchantable sawtimber stumpage destroyed.

Item 30. **Cds**. Enter here the volume of unsalvaged merchantable pulpwood stumpage destroyed.

Item 31. **Growing Stock Losses**. To calculate growth loss due to fire in stands not of merchantable size, use the formula LOSS = A(M•Y•K•S) when

M = mean annual increment per acre at rotation
Y = age of stand at time of fire
K = percentage of stand killed by fire
S = percentage of full stocking prior to fire
A = acres affected.

The formula should be applied separately to stands differing in M, Y, K, or S and the sum of all losses should be entered in item 31.

either positive or negative and may differ for different allotments. Calculate change separately for different situations. The range management staff may be best able to supply these estimates.

Item 37. **Duration of Effect**. Enter here the number of seasons over which the change will continue. In cases where there is a fire-caused production loss but rehabilitation is anticipated, the duration of loss cannot exceed the period between the time of the fire and the time rehabilitation is completed. For example, if no rehabilitation is planned, consider a range fire which causes a change in vegetation which will reduce forage production for 10 to 15 years before the burned area returns to its prefire productivity level. If rehabilitation is planned within 2 years and output will be back to normal within 3 years, only 3 years of forage loss is to be entered in this item.

RECREATION EFFECT ITEMS

Item 38. **RVD's**. Enter one-half of the current annual use of recreation facilities rendered unsafe by the fire.

Item 39. **RVD's**. Enter here one-half of the current annual dispersed recreation use, other than wilderness use and hunting and fishing, for the burned area. This may be based on average annual per acre dispersed recreation use for the forest or fire management area. It is assumed that displaced dispersed recreation use will be relocated within 6 months.

Item 40. **RVD's**. Enter here one-half of the current annual wilderness use for the burned area. The 6-month assumption regarding relocation will be applied to this estimate.

WILDERNESS EFFECTS

Item 41. **RVD's**. Enter here one-half the annual change in recreation vehicle days for the indicated types of fishing and hunting resulting from the fire. This may be estimated by prorating forest level use to the area burned and fisheries influenced by the burned area. It is assumed that hunting and fishing activity will be relocated after 6 months.

WATER EFFECT ITEMS

Item 42. **AF**. Enter any increase in water yield to be anticipated from the burned area in acre feet per year.

Item 43. **Duration of Effect**. Enter the length of time an increase in water yield is expected to continue (until the area is revegetated naturally or through rehabilitation treatment), in years up to 10.

Item 44. **AF**. Enter the water yield from the burned area, which will be of reduced quality because of increased sedimentation or other causes, in acre feet per year. Note that when this effect is significant it relates to the entire water yield from the burned area and not just to the increased runoff.

Item 45. **Duration of Effect**. Enter the length of time a reduction in water quality is expected to continue (until the area is revegetated naturally or through rehabilitation treatment), in years up to 10.

OTHER EFFECTS

Item 46. **Description of Effects**. Enter here a description of any significant fire effects not included above. These may include air pollution, the lost habitats for rare or endangered species, archeological sites, research study plots, and other unique resource losses. The valuation procedures make no attempt to associate an economic value with these effects, but they may be considered on a judgmental basis in fire management decisionmaking if they are noted here.

Item 47. **Presuppression Cost**. This item is to be completed after the end of the fiscal year in which the fire occurred. Presuppression cost for a fire is total presuppression cost for the fire management area, divided by the number of statistical wildfires plus prescription fires which occurred. So, this cost is the same for every fire. Total presuppression cost includes all major appropriated protection management expenditures by the Forest, prorated to the fire management area. Do not include expenditures from Forest Fire Fuels Management. Include unreimbursed presuppression expenditures by cooperators. Divide total presuppression cost by the number of statistical wildfires plus the number of prescription fires.

Item 48. **Suppression Cost**. This item is to be completed after the end of the fiscal year in which the fire occurred. Suppression cost is developed from the average cost per acre for suppression by fire size class. Prorate major direct fire suppression related expenditures and obligations for the forest to the fire management area. Do not include cost incurred while fighting fires outside the Forest. Expenditure records provide a breakdown of expenditures by fire size class. Calculate the average cost per acre burned by fire size class. Multiply the appropriate average cost by the number of acres burned as recorded in item 8. Calculate the average suppression cost per man-day of control effort by dividing total suppression cost by total number of man-days of control effort. Multiply this average cost per man-day by the number of unreimbursed man-days of control effort recorded in item 9. Add this cost to the suppression cost based on area burned to calculate total suppression cost.

Item 49. **Life and Health Loss**. For each person listed in item 10 estimate the cost of medical treatment and of lost work time by the following process. For medical treatment cost, multiply the number of days of hospitalization by $150. This is the 1978 average cost per day of hospitalization for hospitals outside standard

metropolitan statistical areas. For persons known to be hospitalized but where the length of stay is unknown, use $1,000. Use the following data to determine the value of work time lost.

Up to 20 working days: $54 per work day lost
Up to 11 calendar months: $1,160 per calendar month lost
For longer periods:

Years of employment lost *	5 percent present value of work time lost	10 percent present value of work time lost
1	$ 13,900	$ 13,900
2	25,840	24,120
3	37,850	34,750
4	49,290	44,060
5	60,180	52,680
6-10	89,840	74,150
11-15	130,570	98,730
16-20	162,480	114,000
21-25	187,650	123,480
26-35	214,060	129,360
36-45	238,520	135,930

*For deceased persons: 65 years of age at death. These estimates are based on the average GNP per employed person less average personnel consumption per capita and represent the average net contribution to GNP of employed persons. These estimates refer to 1978 and should be updated annually. Medical treatment cost data are derived from American Hospital Association information and also need annual updating. Total the hospitalization and lost worktime costs by fire size class.

Item 50. **Property Loss.** Calculate the value of each item of property loss listed under item 14 as follows: For damaged but repairable property, use the estimate of repair cost shown in item 15. For destroyed property apply the formula:

$$\text{Value} = 1 - \frac{\text{Age}}{\text{Useful life}} \times \text{Original cost}$$

When age is greater than useful life, value is zero. The tabulation below gives useful life estimates for a range of real assets. These are based on Internal Revenue Service estimates which guide business depreciation accounting practice.

Class of property	Useful Life (Years)
Transportation equipment	
Aircraft	6
Automobiles, motorcycles, off-road vehicles, bicycles	3
Buses	9
Light trucks	4
Heavy trucks, tankers, tractors	6
Vessels, barges, and tugs	18
Land improvements	
Roads, sidewalks, canals, waterways, docks, bridges	20
Fencing	10
Production structures and equipment	
Farm buildings (except residences)	25
Agricultural machinery	10
Mining construction	10
Oil and gas wells	6
Logging equipment and machinery	6
Sawmills, portable	6
Sawmills and plywood mills, permanent	10
Pulp and paper mills	15
Other manufacturing facilities	12
Transportation and communications facilities	
Railroad structures	30
Pipelines	22
Telephone and electricity lines	19
Microwave transmission facilities	10
Other structures	
Factories, garages, machine shops, lifts, office buildings, storage buildings	45
Recreation facilities	20
Residences (includes second homes)	25
Agricultural crops and livestock	
Annual agricultural crops	1
Orchards, vineyards, and other perennial agricultural crops	10
Livestock	1

Item 51. **Rehabilitation Costs.** For each rehabilitation treatment listed under item 18, calculate total treatment cost by multiplying treatment area (item 19) by per acre treatment cost (item 20). Total rehabilitation treatment costs.

Item 52. **Timber Effects.** Calculate curr[illegible]

D = 0.198. A discount factor reflecting a 5 percent discount rate and a conversion period of 100 years, and D = 0.100 for the 10 percent discount factor.

Item 53. **Forage Effects.** Calculate the value of forage destroyed by multiplying 2.4 (items 34 and 35). Calculate the present value of future changes in forage output by applying the following formula:

PVF = A•O P•D

when

PVF = the present value of future changes in revenues from forage.

A = the acres of grazing allotments burned (item 36).

O = the average annual per acre change in forage production (item 37).

P = the current price change per AUM (item 35) multiplied by 2.4.

D = a discount factor depending on the duration of effect (item 38) according to the following listing.

Duration of effect	5 percent D	10 percent D
Years		
2	1.86	1.74
3	2.72	2.48
4	3.55	3.17
5	4.33	3.79
6	5.08	4.36
7	5.79	4.87
8	6.46	5.33
9	7.11	5.75
10	7.72	6.14

Add the value of forage destroyed and the current value of future changes in forage output to compute the net forage effect and enter in item 53.

Item 54. **Recreation Effects.** Value recreational use losses shown in items 38, 39, and 40 according to the listing below, sum these losses, and enter in item 54.

	Region	Value per recreation visitor day
ecreation	All	$ 3.00
creation	1, 2, 3, 4, 10	3.00
	5, 6	3.50
	8	2.50
	9	2.00
	1, 2, 3, 4, 10	8.00
	5, 6	10.00
	8	15.00
	9	14.00

Value the hunting and fishing
rn in item 41 according to the
um these changes, and enter

Type of use	Region	Value per recreation visitor day
Anadromous sport fishing	All	$19.50
Other sport fishing	All	5.25
Small game and upland bird hunting	All	7.25
Waterfowl hunting	All	8.00
Big game hunting	All	10.50

Item 56. **Water Effects.** Value water yield increases shown in Item 42 by using the following listing:

	Duration of effect				
	1 year	2-4 years		5-10 years	
Region	5 and 10 percent	5 percent	10 percent	5 percent	10 percent
	Present value per acre-foot				
R-1	$0.75	$2.04	$1.86	$ 4.33	$ 3.65
R-2, 3, 4, 10	0.50	1.36	1.25	2.89	2.44
R-5	2.60	7.07	6.47	15.03	12.66
R-6, 8	1.50	4.08	3.74	8.67	7.30
R-9	1.00	2.72	2.49	5.78	4.87

Value a reduction in water quality shown in item 44 by using this listing:

	Duration of effect				
	1 year	2-4 years		5-10 years	
Region	5 and 10 percent	5 percent	10 percent	5 percent	10 percent
	Present value per acre-foot				
R-1, 2, 3, 4, 6, 10	$ 1.56	$ 4.24	$ 3.88	$ 9.02	$ 7.60
R-5, 8, 9	4.68	12.73	11.65	27.05	22.79

Determine the net effect by subtracting the negative effect of reduced water quality from the positive effect of increased water yield and enter in item 56.

Item 57. **Net Present Values.** Subtract the total of present values for costs and losses from the total of present values for benefits to determine net present values. Indicate negative net present values with brackets.

USING VALUATION DATA

The fire valuation procedures outlined here will provide estimates of the actual costs, losses, and benefits associated both with wildfires and prescription fires. The procedures then will provide experience data for each fire management area; data about costs, losses, and benefits which apply to that area. As valuation data are accumulated it will be possible to group fires of similar size, intensity, and location and to estimate, for example, an average loss per wildfire acre burned. This connects directly with the land management planning and fire management planning processes.

In fire management planning, changes in fire policy and program are tested to see if any would give an improved overall result. Different wildfire management programs have different costs, losses, and benefits. The most economically efficient program is the one where cost plus net loss is smallest.

he following tabulation shows the results of a recent 77) comparison of seven different fire plans for the schutes National Forest. Total cost plus net loss ered widely for the seven plans. The most efficient n had a cost plus net loss of less than half that of the st efficient plan. This points up the importance of efully assessing fire management alternatives before ching a final decision on which of them to implement.

plan er- ve**	Area burned	Fixed, stand-by, and contract costs	Suppression cost	Resource losses	Total cost and loss
	Acres		*Dollars*		
A	1790	2,927,033	155,924	152,673	3,235,630
B	1991	1,954,477	203,662	165,259	2,323,358
C	3174	1,355,469	127,864	201,549	1,684,927
D	2371	1,318,474	77,397	184,722	1,580,593
E	2056	1,246,619	127,704	167,881	1,542,204
F	4223	1,200,000	460,000	300,000	1,960,000
G	2220	1,165,208	417,309	192,499	1,775,016

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. 1972 Base Plan plus all available primary and secondary forces.
. 1972 Base Plan; primary forces only.
. 1972 Base Plan; reduced air with secondary forces.
. 1972 Base Plan; depleted primary air with secondary forces.
. 1972 Base Plan; primary forces reduced and relocated with limited secondary forces.
. Alternative E; primary forces only.
. Alternative E; reduced with limited secondary forces.

he fire valuation procedures require estimates of the nge in resource output due to fire. Predictions of sort can be made fairly readily for timber and ige outputs, but prediction capability is much less for cts on wildlife, recreational use, erosion and imentation, air quality changes, and other effects. It mportant to develop better estimators than now exist. tudy now being carried out in the Forestry Department Colorado State University seeks to develop a computer del which will predict output effects of fire. Models of sort and other research findings which relate fire erience with output change can improve fire uations. For now, however, in most fire management as, judgment will continue to play a large part in imating the impact of fire on resource conditions and puts. But, valuations based on judgment are more ful than no valuation at all.

he most detailed and comprehensive effort at valuation countered during this study was carried out on the geles National Forest, where estimates were made of cost per acre burned for many different fire effects. e analyst found that records of damage were satisfactory only some of his valuation components, and that er methods--including a good deal of judgment--had be used for many components. The Angeles National est office report, "Detailed Probable Fire Damage ues Study," shows that the valuation procedures ommended here may need augmentation in some fire nagement areas. There should be no hesitation to dify or augment these procedures to better fit local nditions.

The analysis of fire management alternatives for the schutes National Forest was carried out using the FOCUS model to provide estimates of the change in distribution of wildfire by size class with change in attack forces. The analysis was limited because fire valuation data were not available. Only Forest Service presuppression and suppression costs were included, although the Deschutes Protection Unit includes private, State, and BLM lands. No estimates could be made of life and health losses, of rehabilitation costs, or of property losses. Resource losses were estimates, a "damage potential," which the report states, "...should be viewed as relative between alternatives but not actual." Better and more complete valuation data are needed if analyses such as this one are to become a dependable basis for fire management planning.

It should be pointed out that the valuation procedures can be used to provide estimates of the physical change in resource output and use, as well as in their dollar value. This means that changes in fire management can be translated into changes in resource output. This is the essential information necessary to integrate fire management into the general land management planning process.

Marty, Robert J., and Richard J. Barney.
1981. Fire costs, losses, and benefits: an economic valuation procedure. USDA For. Serv. Gen. Tech. Rep. INT-108, 11 p. Intermt. For. and Range Exp. Stn., Ogden, Utah 84401.

This paper presents a procedure to aid fire managers and fire planners on the National Forests in developing improved estimates of actual economic costs, losses, and benefits associated with fire management. Procedures are presented in guidebook form and are adaptable to other management situations.

KEYWORDS: fire, fire management, economics cost/benefits, valuation procedure

The Intermountain Station, headquartered in Ogden, Utah, is one of eight regional experiment stations charged with providing scientific knowledge to help resource managers meet human needs and protect forest and range ecosystems.

The Intermountain Station includes the States of Montana, Idaho, Utah, Nevada, and western Wyoming. About 231 million acres, or 85 percent, of the land area in the Station territory are classified as forest and rangeland. These lands include grasslands, deserts, shrublands, alpine areas, and well-stocked forests. They supply fiber for forest industries; minerals for energy and industrial development; and water for domestic and industrial consumption. They also provide recreation opportunities for millions of visitors each year.

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